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Development of guidelines for application of swine manure to optimize nitrogen management for corn

Abstract: *Results from on-farm trials were analyzed to develop guidelines that will help farmers evaluate and improve their manure-N management, including utilizing swine manure as a cost-effective substitute for commercial fertilizer. The experimental methods included use of the late-spring test for soil nitrate and the end-of-season test for cornstalk nitrate to measure N availability at each research site.*

Principal Investigator:

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Budget:

\$25,000 for year one
\$25,000 for year two
\$25,000 for year three

Background

Nitrogen (N) management is a critical issue in Iowa agriculture. Reports of surface and groundwater contamination by nitrate are increasing, while farmers face economic stress because of falling commodity prices and increasing costs of meeting environmental regulations. Land application of animal manure, particularly swine manure, has been an emphasis of land application guidelines. More efficient use of swine manure to replace some of the fertilizer N will benefit not only Iowa farmers but also the environment.

While swine manure has value as a fertilizer, its practical use is limited by high costs of application, odor problems, and variable levels of N content. Hence, land application of swine manure is generally viewed as an inexpensive waste disposal technique rather than a viable N management option. The intensity of public concern about the environmental impacts of land-applied manure adds urgency to the need for better guidelines, ones that have high credibility and acceptability to farmers and others concerned about the environment.

The Iowa Administrative code currently includes guidelines on land application of animal manure. These guidelines, however, indicate maximum permissible rates of manure application. Iowa State University Extension offers improved guidelines to further help farm-

ers select appropriate rates of manure application and adjust rates of fertilization to give credit for nutrients contained in animal manures.

Recent advances in soil and plant testing offer new ways to evaluate and improve manure application techniques as well as to assess N fertilizer needs after manure application. The late-spring nitrate test (LSNT) enables site-specific measurements of N availability for corn growth early in the season. The end-of-season test for cornstalk nitrate levels offers site-specific measurements of N sufficiency for corn growth during the second half of the season.

The objective of this project was to develop a new research-based guidelines for land application of swine manure as N fertilizer for corn. The guidelines were to be created by using the LSNT and cornstalk tissue tests, with a total of six years of on-farm trial observations (three years from prior work and the three years from this project). The guidelines were to be developed specifically for use with the new tests.

Interpretations of all results were based on two key assumptions. One is that corn plants provide the most reliable assessments of N availability to corn plants. The other is that only measurements of corn responses to additional N can be used to assess N sufficiency for corn growth. Following these assumptions, any

method of estimating N availability to corn, or on N sufficiency for corn growth, can be considered useful only if it has reasonable ability to predict responses to additions of fertilizer N under field conditions.

Approach and methods

On-farm trials were conducted at more than 100 sites during this three-year study. Each trial occurred in a cornfield that had received normal applications of manure by the farmer; that is, manure applied in a systematic manner at reasonable rates by using methods deemed most appropriate for the site by the farmer. Aside from the application of commercially prepared N fertilizer, the farmers managed the test areas in the same way as they managed the rest of the field.

Each test area measured 100 by 200 feet and was divided into four blocks of four plots each. Samples were collected from each block for the LSNT. Replicated and randomized fertilizer treatments (0, 30, 60, and 90 lb N/ac) were then applied to the plots. Samples were collected from each plot for the end-of-season test for cornstalk nitrate. Grain yields were measured by handpicking corn from portions of each plot. Students from local high schools' Future Farmers of America chapters assisted in selecting sites, managing the field plots, and preparing samples for analysis.

Data from all trials were analyzed to establish relationships among factors such as amounts of manure N applied, soil nitrate concentration, grain yield potential, yield response to fertilizer N, stalk nitrate concentration, and profits associated with application of the fertilizer N. Where appropriate, data gathered from the 100 trials conducted during the previous Leopold-funded project (#92-28) were included in the analysis.

Results and discussion

It was initially expected that reasonable relationships would be found among rates of manure-N application, soil nitrate concentrations in late spring, and yield responses to applied N. However, the results showed that rates of manure application were essentially unrelated to either soil nitrate concentrations in late spring or yield responses to fertilizer N. Soil nitrate concentrations showed good relationships with yield responses to applied N.

The end-of-season test for cornstalk nitrate was shown to be a reliable tool for comparing the ability of alternative manure management practices to supply optimal amounts of plant-available N. Observed relationships between stalk nitrate concentrations and yield responses to the fertilizer N were used to develop more quantitative interpretations of stalk test than previously available. These interpretations will increase the ability of corn producers to evaluate and improve manure-N management practices on their farms.

Conclusions

Results of this study suggest that current guidelines specifying appropriate rates of manure application may have limited effectiveness in promoting more successful manure management. The considerable variability in losses of manure N soon after application is not appropriately addressed in such guidelines, and the difficulties will become more evident as farmers move toward site-specific management of N.

Guidelines for land application of manure should focus on helping farmers select practical methods to reduce losses of manure N to the environment. This will help farmers utilize swine manure as a cost-effective substitute for commercially prepared N fertilizers. Guide-

lines should also provide a framework for evaluating and improving management outcomes. The evaluations must consider inputs of N from manure and commercial fertilizers to address the efficiency of N use by crops. Outcome-based evaluations can be used to objectively document the economic rewards for improving N management as well as losses of N to the environment.

Impact of results

The research project generated much needed data to enable development of more site and management specific guidelines for manure application to croplands. This project provided farmers with information on measuring outcomes of manure application that they can use to evaluate and improve manure management on their fields. Further study, especially on-farm, will be necessary to make manure management guidelines a widely adopted and commonly used decision aid for farmers.

Education and outreach

Preliminary results of this work have been reported in ten semitechnical publications and 75 oral or poster presentations at field days, seminars, conferences, or workshops. It is



expected that the major educational impact of this research project will occur as comprehensive analyses of results are published in the future.

Agriculture students from several high school FFA chapters participated in activities associated with data collection for this project. Funds from the Raccoon River Watershed Project and the USDA's Sustainable Agriculture Research and Education program helped support students and their involvement in the project. Participants in a United States Information Agency-funded exchange of high school students between Ukraine and Iowa also assisted in the research.

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